K-JUNIOR v2

user manual

K-TEAM

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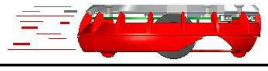

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1 INTRODUCTION

Thank you for buying K-Junior. K-Junior will initiate your experience to the extraordinary world of mobile robotics. Thanks to its wealth of sensors, motors and its software openness, you will be able to create complex behavior, making you an expert of this promising technology.

1.1 The K-Junior Story

K-Junior was developed to replace the actual Hemisson robot which was based on a result from extra-curricular activities of students at the Swiss Institute of Technology (EPFL). The K-Junior is essentially for the education and to learn the base of mobile robotics and programming. The meaning of this new robot was to remove the weakness of the Hemisson and add news features to match with the student and teachers interest.

To simplify the learning, the software was developed on the same base as Hemisson and all extension turrets are compatible with the new K-Junior Robot. All Hemisson's user will be able to upgrade their robot without changing their extensions and learning easily the use of the K-Junior.

1.2 How to use this handbook

This handbook introduces the K-Junior robot and its various operating modes. For a quick start, jump to section 2.2.

If this handbook does not answer one of the problems you are confronted with, please consult the K-Team web site (www.k-team.com) and, especially the Forum and the FAQs

- **Unpacking and Inspection:** K-Junior's package description and first start-up
- **The Robot and its accessories:** K-Junior Hardware overview, accessories and extensions descriptions.
- **Running Modes:** description of the different running modes and how to use it.
- **Reprogramming the K-Junior:** description of the software environment to program the K-Junior.
- **Serial Communication protocol:** description of the Bluetooth and USB serial communication and a list of the different available commands.
- **Extension connectors:** Mapping of the extension connectors.
- **Electronic Schematics:** Schematics of the K-Junior.

1.3 Safety precautions

Here are some recommendations on how to correctly use the K-Junior Robot:

- **Keep the Robot away from wet area**. Contact with water could cause malfunction and/or breakdown.
- **Store your robot in a stable position**. This will avoid the risks of falls, which could break it or cause damage to a person.
- **Use only the official charger or the cable which is delivered with the robot.** Do not try to use another charger; this can cause irreversible damage to the battery.
- **Do not attach any connectors while the robot is powered on**. To avoid any damage, make all connections when the robot power is off.
- **Never leave the K-Junior powered when it is unused**. When you have finished working with K-Junior, turn it off. It will save the battery life

1.4 Recycling

Think about the end of life of your robot! Parts of the robot can be recycled and it is important to do so. It is for instance important to keep batteries out of the solid waste stream. When you throw away a battery, it eventually ends up in a landfill or municipal incinerator. These batteries, which contain Lithium Polymer, can contribute to the toxicity levels of landfills or incinerator ash. By recycling the batteries through recycling programs, you can help to create a cleaner and safer environment for generations to come. For those reasons please take care to the recycling of your robot at the end of its life cycle, for instance sending back the robot to the manufacturer or to your local dealer.

Thanks for your contribution to a cleaner environment!

1.5 Modification since the first Version of K-Junior

The new K-Junior was designed to improve some of limitations of the first version. The new version can be easily distinguished with the name on the stickers on the bottom of the Robot ("K-Junior v2") and with the OS revision (the "B" command will return "b,B-xx" or above). Here's the list of the main improvement:

- More powerful microcontroller with more memory (PIC18F66k22 at 16MHz)
- Better IR sensor management (12 bit ADC with calibration)
- Battery Voltage measurement. The K-Junior can now monitor the level of its Battery.
- Better motor control. The K-Junior can reach a slower minimum speed and the speed regulation is more linear.
- Sound improvement. The K-Junior can now play directly 48 different notes.
- More powerful DC/DC converter for the extension. The maximum current available on the +5V has been improved.

2 UNPACKING AND INSPECTION

2.1 Package Content

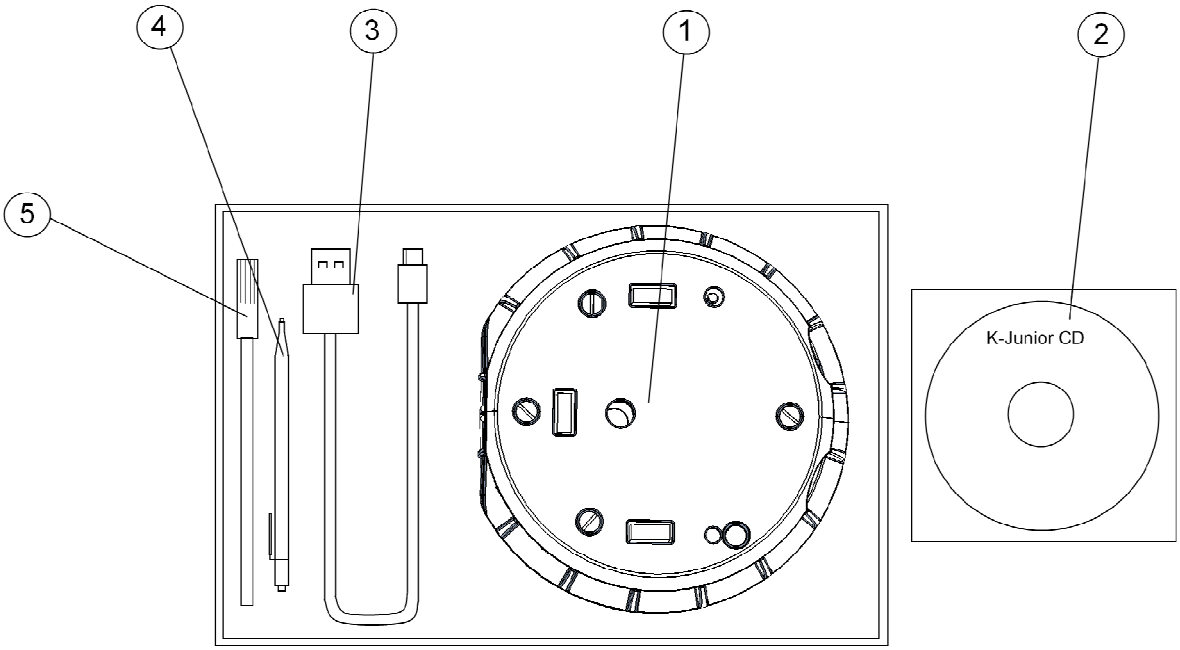


Figure 2.1: Content of the K-Junior Pack

Your package should contain the following items:

1. K-Junior Robot
2. K-Junior Support CD
3. USB to mini-USB cable to charge the K-Junior
4. Screw driver to configure Dip Switch
5. Felt Pen

2.2 First Start-up

Throughout this handbook we will use the following notation to indicate the switch positions:

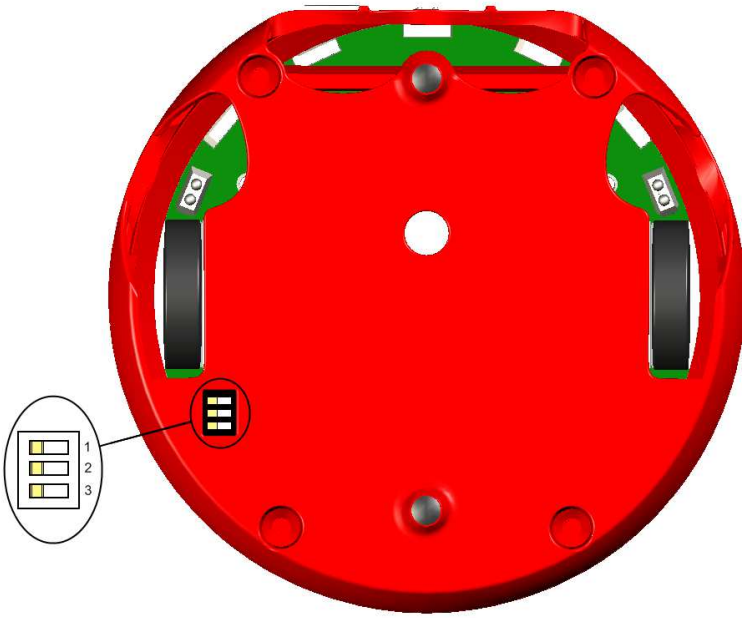


Figure 2.2: Notation of the switches

The test procedure below allows you to check the status of your K-Junior Robot by launching the braitenberg obstacle avoidance mode (see section 4.2 to learn more details about this mode). You will find additional description on your K-Junior Support CD.

Please follow the followings steps:

- Check that the robot is powered off (figure 2.3)
- Configure the switches as indicated below:

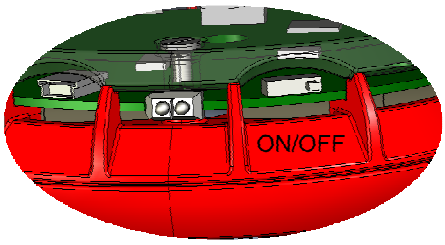


Figure 2.3: ON/OFF switch

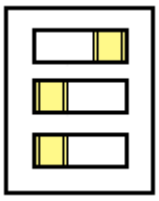
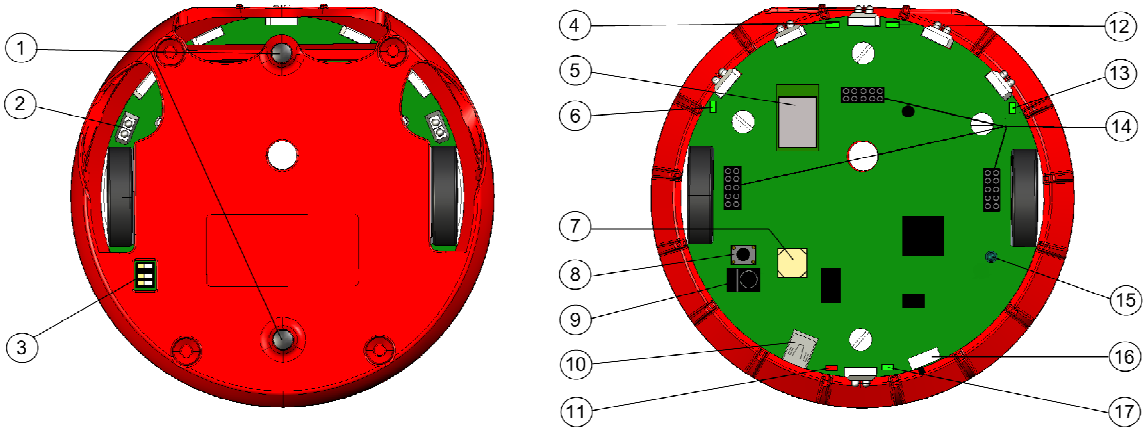


Figure 2.4: Switches settings

- Turn ON the K-Junior by putting the ON/OFF switch in the ON position (left position on the figure 2.3). Now the Led next to the switch must blink
- Put the Robot on a table with different obstacle
- The K-Junior will now move forwards, avoid obstacle and avoid falling of the table.
- If the K-Junior didn't move, please first charge the battery with the USB cable (see section 3.2.9)

3 THE ROBOT AND ITS ACCESSORIES

3.1 Global View



Bottom view Top view

Figure 3.1: Views of the K-Junior Robot

1: ground contact
2: IR proximity sensor
3: Switches selector mode
4: Led 1 (Green)
5: Bluetooth Module
6: Led 0 (Green)
7: Buzzer
8: Reset Button
9: IR remote receiver
10: mini-USB connector
11: Charge Led indicator (Red)
12: Led 2 (Green)
13: Led 3 (Green)
14: Extensions connectors
15: IR emitter led
16: Switch ON/OFF
17: Power ON Led (Led 4, green)

3.2 The K-Junior Robot

3.2.1 Microcontroller

K-Junior's microcontroller is Microchip PIC18F66k22 at 16MHz in SMD packaging. It is one of the most powerful 8-bit PIC of Microchip line card. It works in low power mode with the nanoWatt XLP technology.

Inside the PIC18F66k22, there are three kind of Flash memory

- 64kB of Flash memory
- 3'862 Bytes of RAM
- 1024 Bytes of EEPROM

For more information on PIC18F66k22 internal resources, please consult documentation on Microchip website (http://www.microchip.com).

3.2.2 LEDs

K-Junior has six SMD LEDs. Five programmable and one to indicate the Battery state of charge. By default, when the robot is power On, On/Off Led (Led 4) blinks and the other are turn off. All the programmable Led (led0 to led4) can be configure as automatic mode to blinks. If all the five green leds are set to automatic mode, this will form a scanner lights.

The Battery charge led turn On (Red) when the USB cable is connected to the K-Junior. As soon as the charge is complete, this led will turn Off.

3.2.3 Buzzer

K-Junior contains a Buzzer module which can reproduce up to 48 different note, from the second Octave to the fifth Octave. The table below shows the corresponding note (with its frequency) to the Buzzer value. To turn off the buzzer, set the value to 0.

	Second Octave		Third Octave		Fourth Octave		Fifth Octave	
Note	Value	f [Hz]	Value	f [Hz]	Value	f [Hz]	Value	f [Hz]
Do	1	131	13	262	25	524	37	1048
Re bemol	2	139	14	278	26	556	38	1112
Re	3	147	15	294	27	588	39	1176
Mi bemol	4	156	16	312	28	624	40	1248
Mi	5	165	17	330	29	660	41	1320
Fa	6	175	18	350	30	700	42	1400
Sol bemol	7	185	19	370	31	740	43	1480
Sol	8	196	20	392	32	784	44	1568
La bemol	9	208	21	416	33	832	45	1664
La	10	220	22	440	34	880	46	1760
Si bemol	11	233	23	466	35	932	47	1864
Si	12	247	24	494	36	988	48	1976

3.2.4 IR Remote Control and communication

An IR remote receiver allows controlling the K-Junior wirelessly. This is a 36 kHz demodulator using the rc5 code. You can control or send data to your robot with a standard TV remote control. More information is provided in section 4.8.

An IR emitter allows sending data from one robot to another. The emitter will use the same code (rc5) as a TV remote, but you will be able to choose the Data and the address to communicate with other Robot. More information is provided in section 4.9.

3.2.5 Switches

There are one Dip switch (three channels) and one power ON/OFF switch. The Dip switch is located in the Bottom of the robot (See figure 2.2) and the power ON/OFF switch at the back of the K-Junior (see figure 2.3). The Dip switch select internal behaviors describe in chapter 4.

The ON/OFF switch allows turning On the K-Junior, see figure 2.3 to know the correct sense of the switch. When the K-Junior is turn ON, the Led 4 must blinks. If not, the battery is certainly discharged. Then tried to charge the Robot with the USB cable and at the same time, turn On the Robot.

3.2.6 Infra-red sensors

There are 10 similar IR sensors: six on the side and four facing the ground. As a matter of fact, the sensor includes two components:

- An infra-red light emitter (LED)
- An infra-red light receiver (phototransistor)

Passive mode

In passive mode, only the phototransistor is used to measure the ambient IR emission, also called luminance measurement. For you information, there are many natural or artificial IR sources in your environment, e.g. sunlight, incandescent lamps or a candle flame.

Active mode

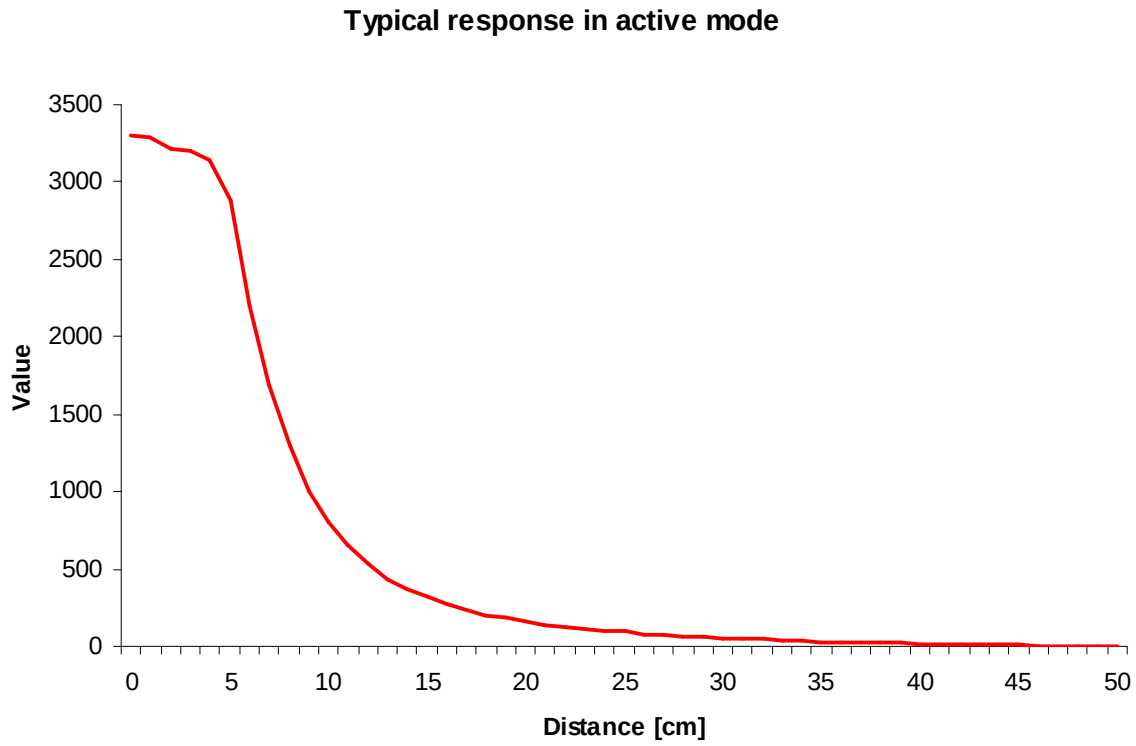
In active mode, IR light is first emitted by the LED and then a measurement of the returned IR light is made by the phototransistor. If there is an object near the sensor, it will reflect IR light. Moreover, the closer the obstacle, the more IR light will be reflected.

However, IR reflection from an object will vary very much depending on the material, color and surface finishing. Usually, the darker the object, the less IR it reflects, but, as you can see below, there are some exceptions:

- White paper: 100%
- White PVC: 90%
- White polystyrene: 120%
- Black on white paper made with drawing ink (Higgins, Pelikan, …): 4-6%
- Black on white paper made with fibber-tip pen, black (Stabilo): 76%
- Plexiglas, 1mm thick: 10%
- Cast aluminium, matt: 45%
- Aluminium, bright: 110%
- Gold plating, matt: 150%
- Brass, bright: 160%

Hence, except if your Robot's environment is made of the same material everywhere, it cannot recover distance, according to the vary nature of the material, it will not measure the same distance for two different obstacles at the same distance. For ground sensors, the active mode will vary according to the material beneath. Hence, the robot can follow a line on the ground or detect table edges if the materials are well chosen (see list above). The position of the 4 ground sensors are made to avoid falling if the robot move forwards.

Last, in order to avoid perturbation by ambient light the robot samples ambient light before emitting IR light. The difference of the two samples values is returned. However, under certain lighting conditions, e.g. sunlight, infra-red sensors may saturate and, therefore, the active mode will return incorrect information. Then, avoid using the K-Junior in outdoor environment, typically when the weather is sunny. In the same weather condition, don't use the Robot too close from windows in a direction of the Sun.



The graph above displays the typical value read on K-Junior while changing the distance from a given obstacle. This example was made with a white paper. You can notice that the response is exponential, i.e. there is no linear correlation between the value read and the distance of the obstacle.

IR calibration

The IR sensor are by default calibrated to improve the detection range. Each sensor has a residual value when no obstacle are present (due to the isolation between the emitter and receiver). This calibration suppress this offset of each sensor, to obtain a value of 0 when the Robot is free of obstacle.

If the sensor value are not near 0 when no obstacle is present, the calibration can be made to match to your environment. But be careful, if the calibration is not made correctly, you can perturb the good behavior of the Robot. Here's the step to follow for the IR calibration:

- Configure the K-Junior in basic mode
- Turn On the Robot and connect it to a computer using the Bluetooth connection. (This calibration cannot be made if the USB cable is connected).
- Send the command "K".
- A message will ask you to place the K-Junior on a surface without any obstacle around.
- Once the place cleared of obstacle, type "Enter". This will calibrate the six Proximity sensor.
- Then a second message will ask you to return the K-Junior (place it on the back), and be sure that no obstacle are in front of the Ground sensor.
- Type "Enter", this will calibrate the four ground sensor
- Finally, a last message ask to place the K-Junior on a white surface. This will calibrated the two ground sensor for the line following (only firmware B-03 and higher).
- Once the K-Junior on a white floor (if possible the same that will be used for line following), press enter. This will saved the white level and saved the value in the EEPROM.

Do not calibrate the IR sensor to many times, as the write to the EEPROM are limited! Do it only when necessary.

3.2.7 Bluetooth communication

A WT12 from Bluegiga is integrated in the K-Junior to allow Wireless communication with a PC and other Robot. This module is a class 2 Bluetooth 2.0 + EDR (Enhanced Data Rates). At the power on, the module waits for a communication which must be established by a PC. It will be seeing as a Bluetooth serial port with a name like "K-Junior 1234", where 1234 is the serial number of the Robot.

Once the communication established, you will be able to remote control your Robot through a COM port using the serial protocol commands. With one Bluetooth dongle, you can communicate with up to 7 K-Junior at the same time.

With this K-Junior v2, you can now upload your own application through Bluetooth or update it with a new firmware using the K-Junior Uploader software.

If you want to make a small network without any PC, you can use the iWrap command of the module to scan, connect and create a network. For more information about the WT12 and its iWrap firmware, please see on the Bluegiga web site (http://www.bluegiga.com) and search the datasheet of the WT12 module.

3.2.8 USB communication

The K-Junior has an integrated USB to serial adaptor chip, which allows connecting your Robot to your PC with a mini USB cable. At the same time you communicate with the K-Junior, the USB will charge the battery. This communication method is not the best to keep the Robot's mobility. You can also use this method to update your K-Junior and to program it with your own application.

3.2.9 Battery

The K-Junior has an integrated 3.7V Li-Pol battery pack, with a Capacity of 1200mAh. This battery ensures autonomy up to 4 hours without additional turret. The charging circuit is integrated in the Robot to allow a charge with a mini USB cable and a PC. The Charging time is approximately 4 hours when connected to a computer.

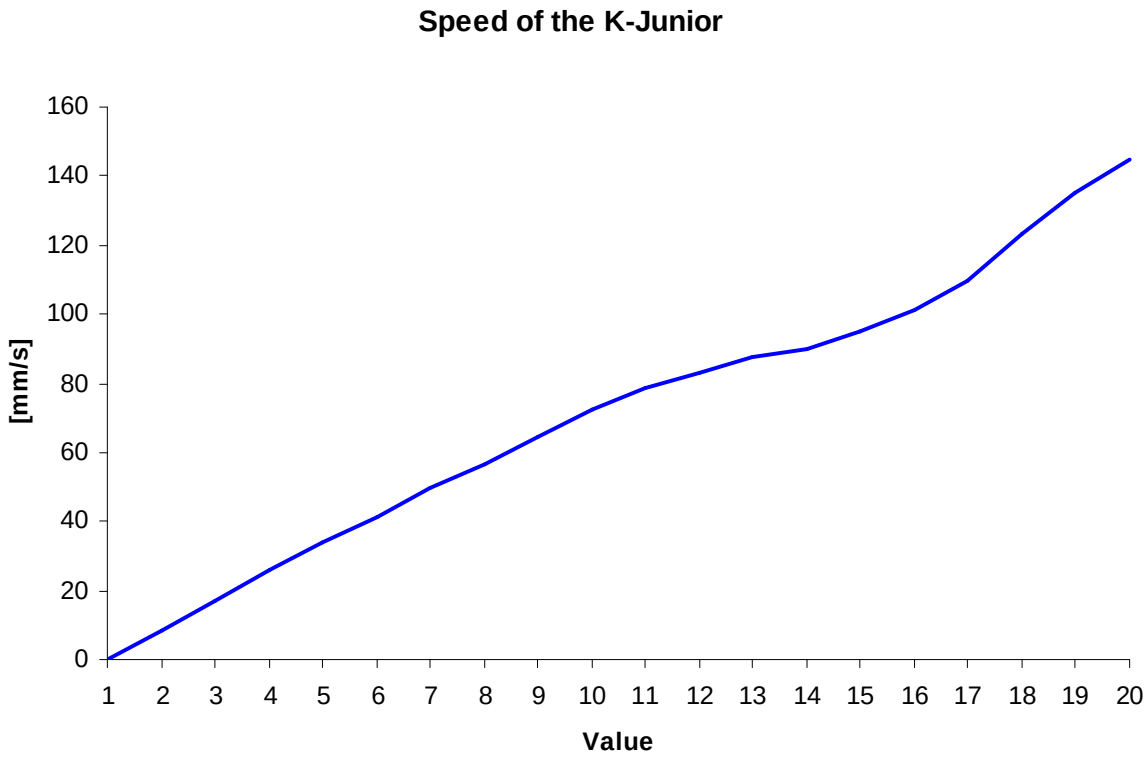
The charge Led (red) turn on during all the process of the charge. As soon as the battery is completely charged, the red Led will turn off.

The K-Junior can monitor the voltage of its battery using the command "S" (see chapter A "Communication Protocol"). The returned value correspond to the analog result of the 12-bits ADC. To convert it to the real voltage, please use the formula below:

$$BatteryVoltage = \frac{Value}{4095} \bullet 3.3 \bullet 2 = \frac{Value}{620.5}[V]$$

3.2.10 Drive mechanism

K-Junior uses two Direct Current (DC) motors to drive its two wheels. It is a differential drive system. The main advantage of this system is related to steering. By making the motors turn in opposite directions, the robot will spin around its own axis, which makes it much more maneuverable than a system that can only turn as it moves forwards. Differential drive also makes it very easy to make turns because it just depends on the relative speeds of the motors.



These measures were made on a desk with a fully charged battery, and no turret plugged on the K-Junior. Due to its open loop motors, it's impossible to guarantee the speed for a given consign. The speed value will determine the PWM percentage, where 20 is the maximum (100% of Duty cycle). A minimum PWM percentage is fix to 30% (value = 1) because lesser PWM didn't provide enough power to move the Robot. To calculate the PWM percentage, use the following formula:

$$PWM[\%] = \frac{Value}{20} \bullet 70 + 30$$

3.3 Accessories

We will detail hereafter accessories included in your K-Junior Pack

3.3.1 Mini USB cable

We provide a mini USB cable to connect your K-Junior to your computer. For that, your computer must have a standard USB port. Once the K-Junior connected to your computer, this one will ask you to install a new material. This is the USB to serial chip which is on the K-Junior. Choose the driver provided on the K-Junior CD (or on our website). The driver will now assign a COM port to your K-Junior, and allows you to communicate with it through a terminal (see section 4.6).

Once your driver will be installed, the charge of your K-Junior will start with a current of 400mA. This cable will be useful to update and/or to load your program into the K-Junior. So, even if you used always the Bluetooth to communicate, keep this cable carefully. If you loose it, you can buy a new one from your local computer store.

3.3.1 Felt Pen

A felt pen is provided with the K-Junior to draw K-Junior's trajectory. You must set it in the hole, right in the middle (see picture below). First, switch Off the K-Junior, then remove cap and insert firmly the pen in its location while holding the K-Junior in your hand. Adjust the height of the pen, so that the wheels touch the ground. Finally, you should test it; for example, by setting K-Junior in dance running mode (refer to section 4.4). Most of the time, you will need to adjust the position slightly. If the pen rubs the ground too much, push it up slightly while turning it. If it does not have enough contact, push it down slightly while turning. This is a very tight adjustment, and you will need a few trials before success, especially in the beginning.

Figure 3.3: Felt-Pen in its location

3.3.2 Screw driver to configure Dip Switch

A screw driver is provided with the K-Junior to simplify the configuration of the dip switch. You can use another tool to change the dip switch, but this screw driver will avoid damaging the dip switch. So, please use this screw driver to keep your Robot in a good condition.

3.4 Extensions

K-Junior has an open architecture: 3 extensions connectors allow to add devices, either made by K-Team S.A. (cf. www.k-team.com), or that you will build yourself.

Each of the three extensions connectors is dedicated:

- Front connector provides I^2C bus communication and power supply
- Left side connector allows flash-memory programming
- Right side connector ensures a good mechanical fixing.

You will find all the information to build you own devices in connector pinning schematics in the Appendix B, and in K-Junior schematics in Appendix C

All the Hemisson Extensions are fully compatible with the K-Junior robot (and inversely). Then all the following extensions will have the prefix “Hem” but can be used with the K-Junior.

3.4.1 HemLinCam

The HemLinCam module allows K-Junior to perceive its environment. The camera reads one line of 102 pixels in 256 level of grey. The optic block is a standard one (M12x0.5), so that you can change it to fit to your specific needs. As in all the intelligent K-Junior modules, there is a board processor (PIC16F876), dedicated here to visual processing. Like K-Junior, the source code of the visual processing in under LGPL license and, as a consequence, you can write your own visual routines. To download your own code on HemLinCam, you can use the same tools as for K-Junior (CCS C, In-Circuit-Debug Interface, and External Programmer Interface).

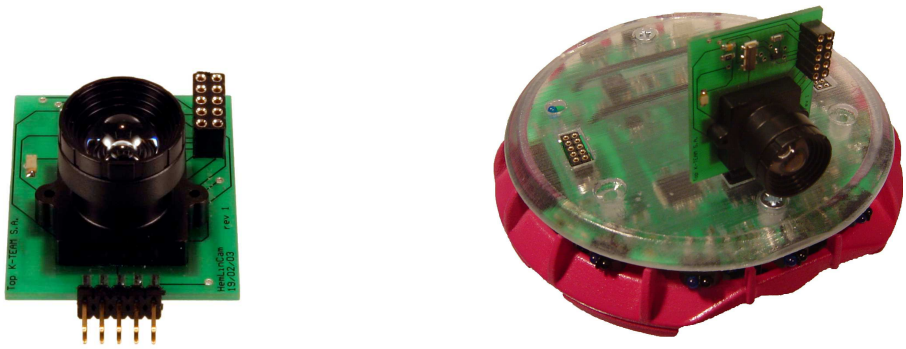


Figure 3.4: HemLinCam

3.4.2 HemGenIO

The HemGenIO allows interfacing your own electronics. It is a perfect tool to implement your own module. A board area allows you to add components (2.54mm/.1" spacing). The documentation explains how to access your own peripherals from the central processor (12 digital I/O, 5 analog 8-bit inputs and I2C bus).

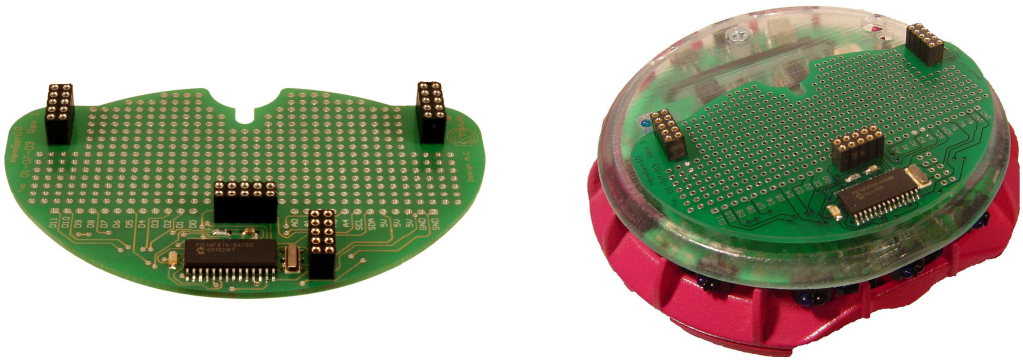


Figure 3.5: HemGenIO

3.4.3 HemTextToSpeech

This interface makes your K-Junior speaks fluent English. The on-board speaker will pronounce every word downloaded in ASCII code on K-Junior I2C bus.

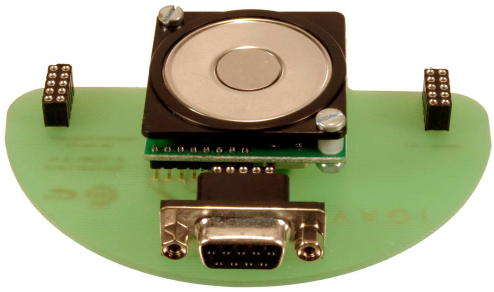
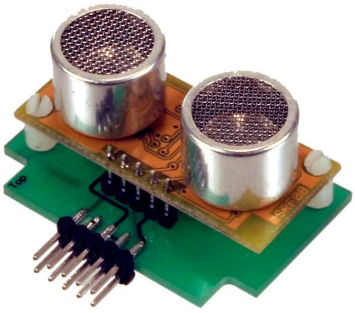


Figure 3.6: HemTextToSpeech

3.4.4 HemUltraSonicSensor

If you are looking for a higher range than the default K-Junior sensors, this ultrasound sensor allows the K-Junior to measure distances of up to 6 m with a 1 cm precision.



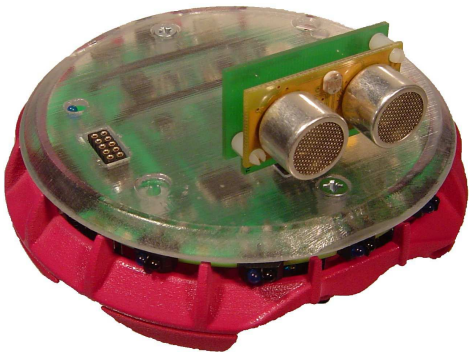


Figure 3.7: HemUltraSonicSensor

3.4.5 HemGripper

If you want to transport object with your K-Junior, the Gripper allows grabbing object up to 30g with different shape, and size (1mm to 70mm). The Gripper movement is made by two servo DC motors, which are controlled by a local microcontroller (PIC16F690). Because this extension uses high current, two versions are available. The Deluxe version with an additional battery to keep the 3-4 hours of K-Junior's autonomy, or the Gripper LE with only the electronic and the mechanic which will decrease the K-Junior's autonomy to 1-2 hours.

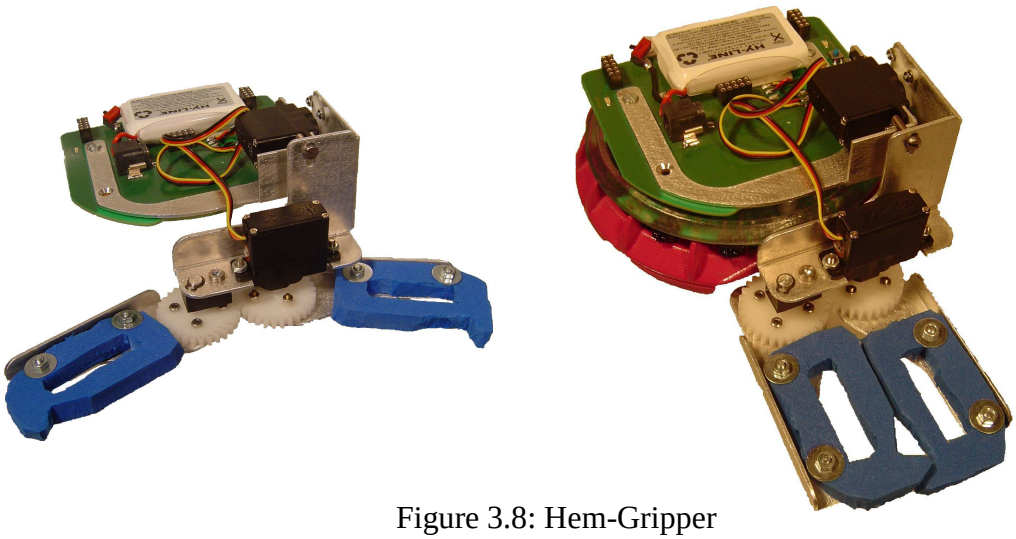


Figure 3.8: Hem-Gripper

3.4.6 HemWirelessCam

The HemWirelessCam extension is a small color camera which allows you to watch what the K-Junior see on a TV without any cable. You can increase this functionality by connecting the receiver to a frame grabber to make image processing, and use Bluetooth communication to remote control your K-Junior.

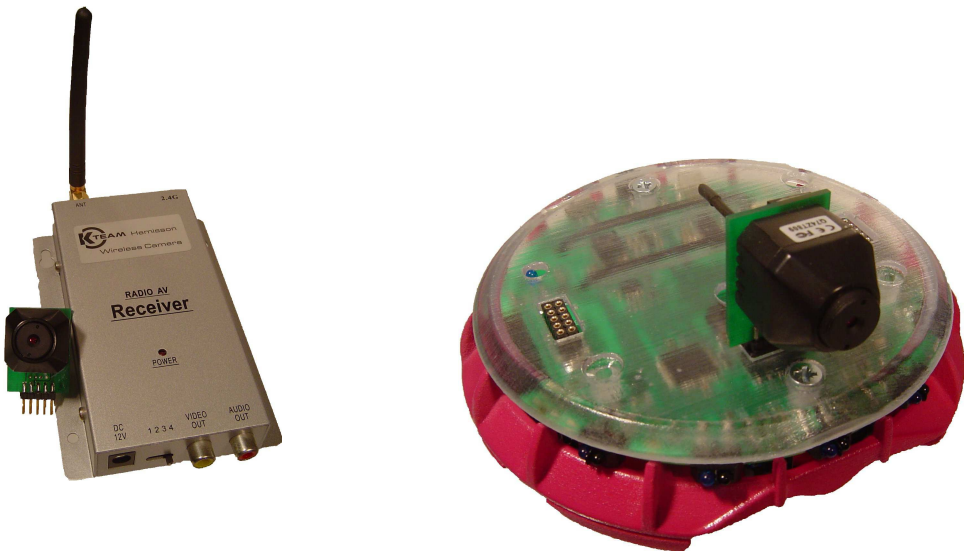


Figure 3.9: HemWirelessCam

4 RUNNING MODES

The K-Junior starts in the run modes selected by the position of the Dip Switch (see figure 2.2). This value will be read continuously when the K-Junior is powered, but the choice of which modes must be run is made only after the boot. If you want to change the running modes, you must reset the K-Junior.

For all operations described in this section, the KJ-Firmware must be installed (by default) in the Robot. If you have changed the program with one of your application, these modes won't be executed automatically. The demo program source code are note provide with the KJ-OS code. So if you want more information on how these program are made, please contact K-Team S.A. (info@k-team.com)

4.1 Remote Control

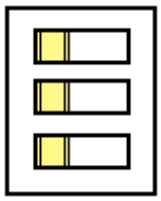


Figure 4.1: Settings for the Remote-Control Running Mode

This mode allows initializing the Robot in controlled mode. The K-Junior will make its entire background task (refreshed IR value, Read IR receiver, read serial port) but will do nothing until a command arrives from the serial port or the IR receiver. This configuration is valid to control via USB serial port (see section 4.6), Bluetooth communication (see section 4.7), via IR remote control (see section 4.8) and for use with Webots-K-Junior.

4.2 Obstacle and fall Avoidance

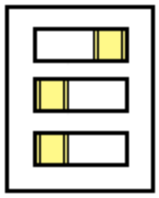


Figure 4.2: Setting for the Obstacle and fall avoidance running mode

In this running mode. K-Junior detects obstacle in front of it and avoids them. It use a special algorithm called Braitenberg, this kind of program allows a fluid movement of the Robot when it detects a obstacle. The Robot uses at the same time its four ground sensor to avoid falling of the table. If the robot detect that it doesn't touch the ground (i.e. you have it in your hand), the motors will be turn off.

To use correctly the fall avoidance, you must have a table (or a desk) with a sharp edge, otherwise the K-Junior will see the end of the table too late and one of its wheels could fall. Try to avoid different ground color, if your Robot coming from a white ground to a black ground, the K-Junior will interpret the black area as a hole and will avoid it.

Beware of any parasite source of infra-red light, like incandescent lamps and sunlight that can perturb K-Junior's behaviour

4.3 Line Following

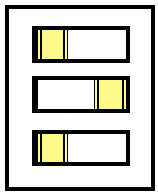


Figure 4.3: Setting for the Line-Following Running Mode

K-Junior can follow a line by reading the value of its two front ground sensor. The line must be a black line over a white ground and must at least 20mm in width. You will find printable track sections on the CD-Rom in the "Extras" directory. When you make your circuit, do not make too acute angle where the K-Junior won't be able to turn.

Beware of any parasite source of infra-red light, like incandescent lamps and sunlight that can perturb K-Junior's behavior

4.4 Dance

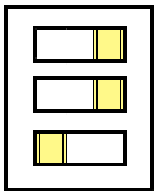


Figure 4.4: Settings for the Dance Running Mode

In this mode, K-Junior carries out a circular “dance”. If you add a felt-pen in K-Junior’s centre, K-Junior will draw an unstable hypocycloid (more information on hypocycloid at: http://mathworld.wolfram.com/Hypocycloid.html).

4.5 Song

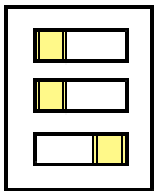


Figure 4.5 Settings for the Song Mode

The K-Junior will play a song (“Au clair de la lune”) in the four available Octave.

4.6 USB Serial Port Control

You can control your K-Junior via an USB port. Follow these steps to install, configure and use your K-Junior through the serial USB port:

- Connect your K-Junior to your computer with the Mini-USB cable provided with the Pack.
- Select the Remote Control Mode (see section 4.1) and turn On the K-Junior
- The K-Junior will be seen as a new hardware device and your computer will ask for a driver. Select the driver (K-JuniorUSBDrivers.zip) provided on the CD-Rom. This will install the USB to serial adapter which is integrated on the K-Junior.
- **Note: if you have many K-Juniors, you have to install only one time the driver. The other Robot will be detected automatically.**
- The K-Junior will now be recognized as a serial COM port.
- Now you have to parameterize the driver to configure the baud speed of the K-Junior.
- Open your Hardware device manager, and right clicked on the K-Junior device. Select **Properties**, and in section **Port Settings,** set all the parameters as shown in Figure 4.6.

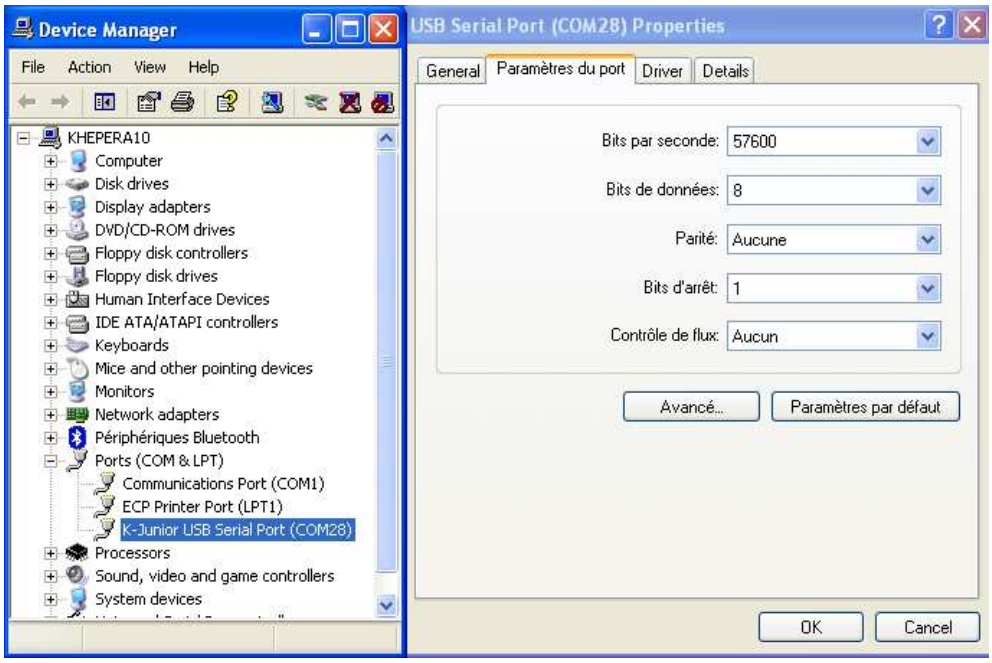


Figure 4.6: USB driver settings

Note: This configuration must be done only at the first start-up.

- To communicate with the Robot, you have to open a terminal software like HyperTerminal or TeraTerm,

- Select the correct COM port (see in the hardware Device manager to know the K-Junior's allocated COM port) and the correct settings:

    - 57600 Bits per second
    - 8 Data bits
    - No Parity bit
    - 1 Stop bit
    - No Flow Control

- Reset the K-Junior by pressing the reset button (see element 8 at Figure 3.1)

- You should see a boot message similar as in figure 4.8. If not, verify that your K-Junior is correctly powered (power On Led blinks), that the settings of the terminal and the USB driver are correct.

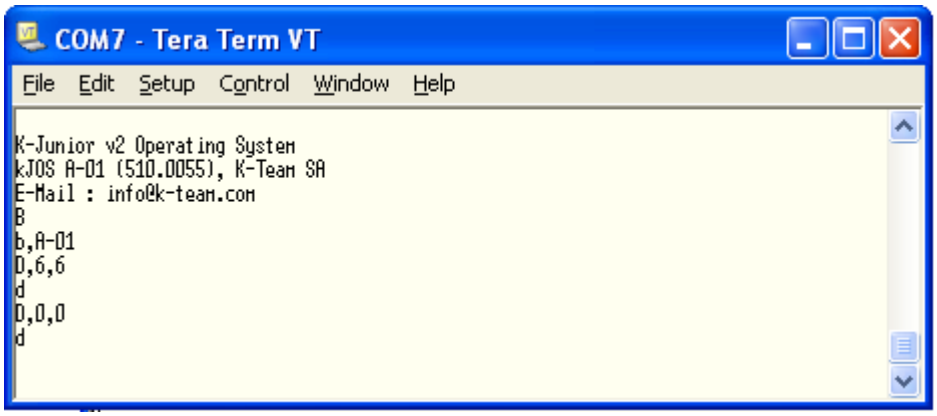


Figure 4.8: K-Junior boot message and commands on a terminal

Now you can send command to test your K-Junior (see Annexe A, Serial communication protocol for more details on available commands). Here's an example sequence of commands to test the K-Junior:

- Type: **B↵.** K-Junior should display the version and revision of the KJOs firmware.
- Type: **D,6,6↵.** The K-Junior should move forwards.
- Type: **D,0,0↵.** The K-Junior should stop

Notation:
↵ Stands for the Enter or Return key on the Keyboard.

Note: if you disconnect your mini-USB cable from the K-Junior or from the computer, you must restart the terminal to re-connect to the Robot.

4.7 Bluetooth Communication Control

If you want to remote control your K-Junior and keep its complete mobility, the best solution is to use the Bluetooth Communication mode. This feature will allow you to communicate with your K-Junior up to 20 meters without cables. Follow these instructions to establish your first Bluetooth connection

- As the USB serial Port control, you must configure the K-Junior in Remote Control Mode (see section 4.1).

- Turn On your K-Junior and verify that it's correctly powered (Power On Led blinks). If not, charge the battery with the mini-USB cable.

- Connect or turn ON your Bluetooth dongle on your computer and search for available Bluetooth device.

- The K-Junior device must appear as a PDA with only the serial port service. Its name will be "K-Junior 1234", where 1234 is the serial number of the Robot.

- Establish the connection with the K-Junior. Your computer will ask you for a security password, enter "**0000**".

Note: this password is asked only at the first connection with the K-Junior

- Your computer will now allocate a COM port to the K-Junior.

- Now open a terminal for the allocated COM port with the same settings as explained for the USB Serial Port Control (section 4.6)

- Reset the K-Junior by pressing the reset button (see element 8 at Figure 3.1) to see the K-Junior's boot message

- Try to send some commands as explain before to validate the communication

Note: Now the connection will be made automatically as soon as you will open the allocated COM port. But, if you connect another Bluetooth serial port when the K-Junior is turn Off, you must re-make the connection manually to allocate the K-Junior to the COM port.

For your information, you can use any third party software, like MATLAB, Labview, (etc…) to control your K-Junior through the USB serial port or through the Bluetooth communication. You can also write your own software to control the K-Junior.

4.8 Infra-Red Remote Control

In order to proceed, your infra-red remote control must follow the RC5 standard. Many TV sets are provided with RC5 remote control. Of course, if you have a programmable remote control, you can emulate the RC5 standard. You can also purchase a remote control at K-Team.

Note: You must us the TV remote control mode and not the VCR mode or any other auxiliary devices. If you are using a universal remote control, you must first set your remote control in TV mode.

As a matter of fact, signals differ for a TV keyboard and a VCR keyboard to avoid cross-communication. Once the compatibility problem settled, you must set your K-Junior in remote control mode (see section 4.1). The available commands are (refer to figure 4.9):

- Button 1: Moves leftward in a large circle.
- Button 2: Move forwards.
- Button 3: Move rightwards in a large circle.
- Button 4: Turn on itself (counter clockwise).
- Button 5: Stop.
- Button 6: Turn on itself (clockwise).
- Button 7: Same as 1 but moves backwards.
- Button 8: Moves backwards.
- Button 9: Same as 3 but moves backwards.

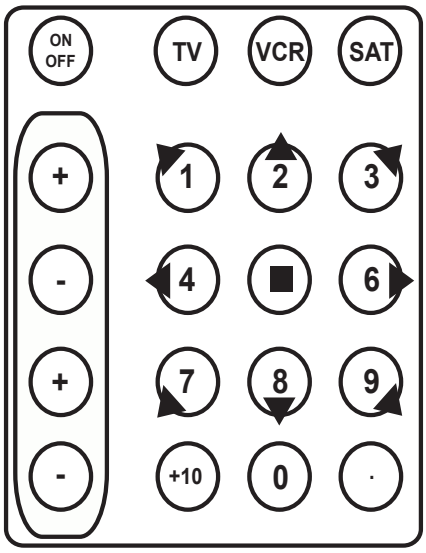


Figure 4.9: Remote Control Keyboard.

4.9 IR emitter, short range communication

The IR led Emitter allows a short range communication between many K-Junior. This features can be used when no Bluetooth Network is made or to send small Data to another Robot. The IR emitter will used the same code as a TV remote control (rc5 code). If you send a data to another K-Junior in Remote Control Mode (command 'V', see Annexe A), this one will execute the command as in the infra red control mode.

But if you made your own program, you will be able to establish a network with a special protocole. For example, each Robot will have a different address to know who is speaking.

Note: When the K-Junior emitting a Data, its receiver is disable. Then if two Robot send at the same time a Data, this one will be lost.

The range of the IR emitter is defined by its opened angle. As shown in the figure 4.10, it must have a refletive roof (white) above the K-Junior. The height will determine the maximum distance of communication between two Robots. But, if the height is too big, the signal strenght will be no more suffisant to transfer Data.

Then we recommend to limit the height (h in the figure) at maximum 1m, this will define the maximum distance (d) between two Robot to approximatively 1m.

Note: Choose a good IR reflecive roof to have the maximum range.

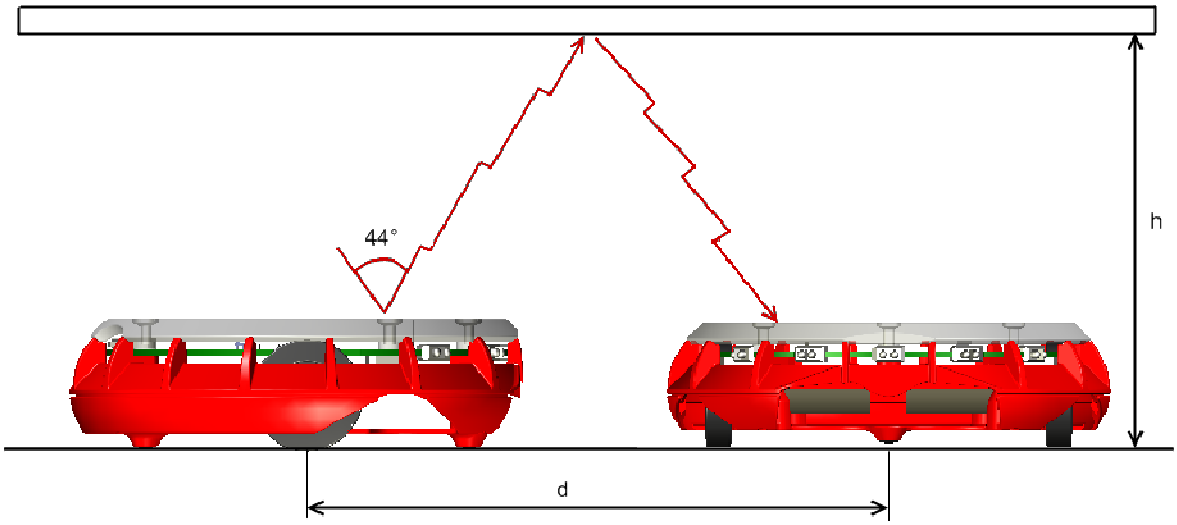


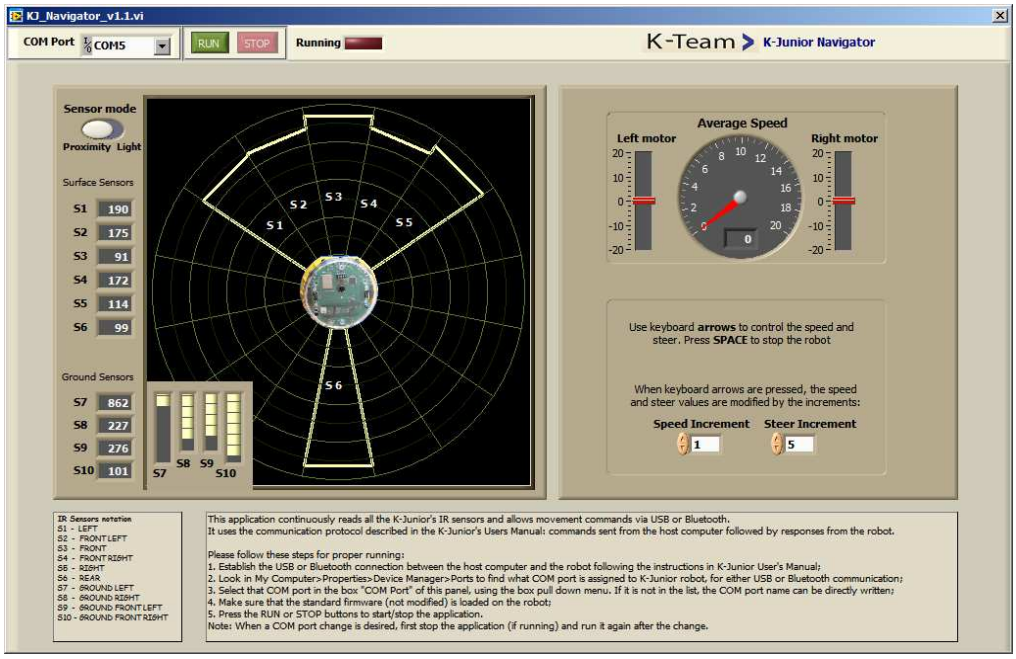
Figure 4.10: IR emitter maximum range

4.10 Software Tools for K-Junior

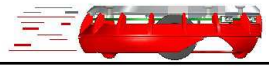
You can find there some applications software for the K-Junior:
http://ftp.k-team.com/K-Junior/software/Applications/Binaries/

Navigator_Stand_alone_app.zip : GUI Navigator for the K-Junior (note that this application was develop for the old K-Junior, the value of the IR sensor are different now (12 bits), the display will fail for all the value above 1023).

This is KJ_Navigator application, a simple and user-friendly interface created for illustrating the main capabilities of the K-Junior Robot.



5 REPROGRAMMING K-JUNIOR



A boot loader is inside the K-Junior Memory. It allows the update of the K-Junior with the K-Junior Uploader (see in the CR-Rom). You can also upload your own program to replace the K-Junior Firmware.

Beware, uploading your own code inside K-Junior's memory means that you are responsible for damages caused to its memory. Do not download a Firmware below the version B-01 inside the K-Junior v2. Use only the firmware provided in the CD-ROM.

The serial port upload process relies on this boot loader locate at the bottom of the memory. At the boot, the loader will wait 1 second before launching the application write in Flash. If a special character is received from the serial port, the boot loader will start to write the new firmware in the memory.

If your code overwrites this piece of code, you will need the external programmer interface (HemICDadaptor or HemFlexExtProg) and an adequate PIC programmer to reprogram the K-Junior. You can also return the K-Junior to K-team S.A., but this kind of repair is not covered by the warranty.

5.1 K-Junior Uploader

You will find the installer on the CD-Rom provided with the K-Junior Robot. First Install it on your computer and run it. The window shows below must appear if the install was correct.

With this application you can upload your own code inside the K-Junior or update it through Bluetooth or with the USB cable. If you choose to upload your own code with Bluetooth be sure that the Battery is charged enough to avoid any problem during the process. With the USB cable you are sure that the supply will be correct as the Battery will be charged at the same time.

First you need to turn on and connect your K-Junior to your computer (with Bluetooth or USB). Your computer must assign a COM port to the K-Junior. Then open the K-Junior Uploader and select the COM port of the K-Junior is the tab.

Then click on the "Browse" button to select the file that you want to upload in the K-Junior. **The first time, try to upload the "KJ-Firmware_B-01" or greater to test if the process works fine.**

Then hold the reset button on the K-Junior and press "Start". Once the message "Press the Reset switch on the Kjunior and Wait" appear, release the reset button. The K-Junior Uploader will now process to the uploading.

Once the Progression tab is complete press on the "OK" button. You application is now completely uploaded in the K-Junior.

5.2 CCS C Compiler

If you aim at accessing directly K-Junior's hardware or make your own on board software, you may use the CCS C Compiler. This Compiler is the development environment of the K-Junior's firmware (KJOs). KJOs is under GPL, and as consequence, you will be able to modify it. See in the KJOs manual to learn more about the source code, the available functions and the compiler.

You will find the latest source code and the manual of the KJOs on the web site:
http://www.k-team.com/mobile-robotics-products/k-junior/manuals-downloads

You can purchase a cheaper version of CCS at K-Team which is limited to the K-Junior's microcontroller. If you want more information about the compiler, please refer to the official web site http://www.ccsinfo.com/.

Be aware that the compiler is now different from the old K-Junior as the uController are not the same. The KJOs are different too. So do not used your old source code with K-Junior v2. Please use the one provided with the K-Junior v2 Robot. But you can easily copy your piece of old code inside the new KJOs and adapt it to the new functionalities of the Robot.

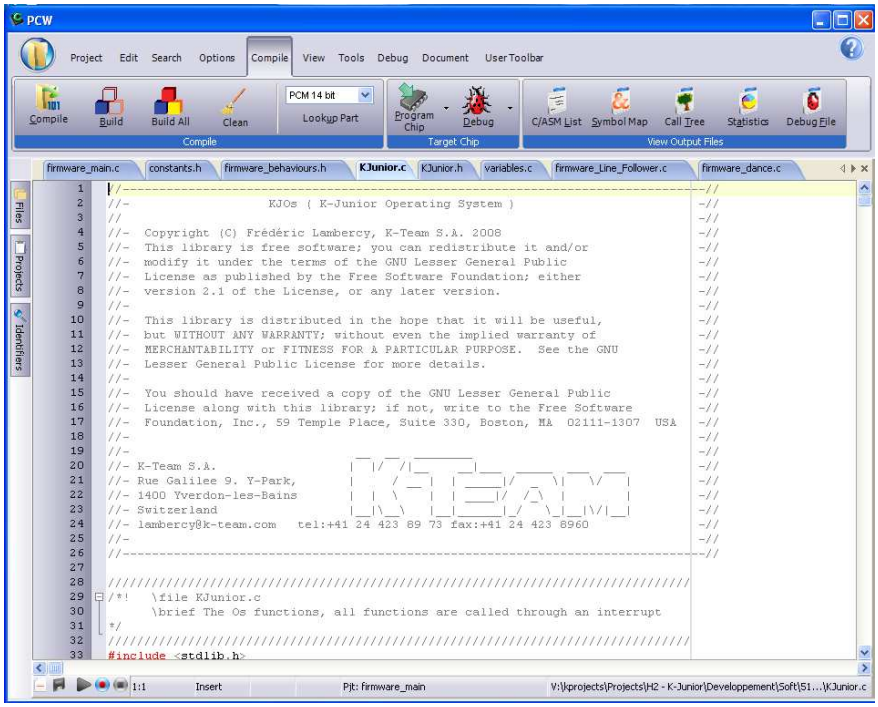


Figure 5.2: CCS C Compiler (PCW version)

5.3 Getting started reprogramming

You can find an user manual for getting started to reprogramming there:

http://ftp.k-team.com/K-Junior/manuals/Intro_K-Junior_C_flow.pdf

Source code examples and other manuals are available there:

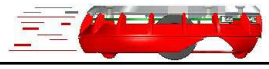
http://www.k-team.com/mobile-robotics-products/k-junior/manuals-downloads

5.4 Others

You are also free to use any other PIC development tools to program K-Junior, as soon as you can build a Hex file, you will be able to use the K-Junior Boot loader. The only problem is you will be obligate to remake all the KJOs basic functions by your own.

Beware, we recommend having a PIC programming experience for the operation. We do not make support on other development environment than CCS. We recommend purchasing the CCS C Compiler.

A COMMUNICATION PROTOCOL



This communication protocol allows complete control of the K-Junior's functions through an USB or a Bluetooth serial line. The required configuration is presented in section 4.6 (USB) and 4.7 (Bluetooth).

The protocol is made of commands and responses, all in standard ASCII codes. A command is sent from the host computer to the K-Junior: it is starting with an upper case alpha character and followed, if necessary, with numerical parameters separated with comma and terminated by a line feed. The response is sent by the robot to the host computer: it is starting with the same character that was initiating the command but using lower case, and followed, if necessary, with numerical parameters.

To better understand this protocol, please refer to the USB serial communication test (section 4.6).

Notation:

↵ Stands for carriage return (Enter or Return key pressed)
\r stands for ASCII character 0x0A (line feed)
\n stands for ASCII character 0x0D (carriage return)

A Move the robot during a define time

Format of the command: **A,speed_motor_left, speed_motor_right, time ↵**
Format of the response: **a \r\n**

Effect: Set the speed of the both motors during a define time. The unit of the time is 100ms, so a value of 15 will move the robot during 1.5s, then stop the motors.
Example: **A,-7,7,15↵**

B Read firmware version

Format of the command: **B ↵**
Format of the response: **b,version_KJOs \r\n**
Effect: Return the software version stored in the flash memory

C Reserved

D Set Speed

Format of the command: **D,speed_motor_left, speed_motor_right ↵**
Format of the response: **d \r\n**

Effect: Set the speed of the both motors. 0 will stop the engine. Maximum forward speed is 20 and maximum backward -20
Example: **D,7,-7↵**

Note: If you set a value bigger than 20, the K-Junior will limit by it self to 20

E Read Speed

Format of the command: **E ↵**
Format of the response: **e, speed_motor_left, speed_motor_right \r\n**

Effect: Read the speed of the motors. As the motors is in open loop, this value will the same as the last Set Speed command

F Read Time Stamp

Format of the command: **F ↵**
Format of the response: **f, time_stamp \r\n**

Effect: Read the time stamp base. The unit is the millisecond, and the maximum time is based on a 32 bits variable (more than 1000 hours). This value is reset at each boot.

G Reset Time Stamp

Format of the command: **G↵**
Format of the response: **g \r\n**
Effect: Reset the Time Stamp base.

H Buzzer

Format of the command: **H,note↵**
Format of the response: **h \r\n**

Effect: Configure the frequency of the Buzzer. 0 will turn it Off. 1 is Do (131Hz) and 48 is Si (1975Hz). Please refer to section 3.2.3 to select your desired note.
Example: **H,13↵**

I Read Switches

Format of the command: **I ↵**
Format of the response: **i, value \r\n**
Effect: Read the value of the dip switch setting.

Note: switch 1 is LSB and 3 MSB (see figure 2.2).

J Scan the I²C Bus

Format of the command: **J ↵**
Format of the response: **j,extension_address \r\n**
Effect: Scan the whole I²C Bus to detect which extension is plugged. The returned value is in Hexadecimal.

K IR calibration

Format of the command: **K ↵**
Format of the response: "**calibration instructions"**
Effect: Calibrate the IR sensor. This operation is already made at the factory. Do it only if really necessary. Refer to section "IR calibration" for more details.

L Change Led State

Format of the command: **L, led_number, led_value↵**
Format of the response: **l \r\n**
Effect: Configure the state of the selected led (0 to 4). Value 0 will turn it Off, 1 = On, 2 = toggle and 3 = blinks.
Example: **L, 2, 1↵**

Note: If you change the state of the Power ON Led (Led4), it will stop blinking and change to your desired state.

M Unused

N Read proximity sensors

Format of the command: **N ↵**
Format of the response: **n, Left, Front_Left, Front, Front_Right, Right, Rear, Ground_Left, Ground_Front_Left, Ground_Front_Right, Ground_Right \r\n**

Effect: Read the 12 bit (0 to 4095) proximity value of each infra-red sensors.

Note: The smaller the value, the further the object is from it. A value of 3000 (i.e.) means that an obstacle is very close from the sensor.

O Read ambient light sensors

Format of the command: **O ↵**
Format of the response: **o, Left, Front_Left, Front, Front_Right, Right, Rear, Ground_Left, Ground_Front_Left, Ground_Front_Right, Ground_Right \r\n**

Effect: Read the 12 bit (0 to 4095) brightness value of each infra-red sensors.

Note: A value of 0 means that the sensors is saturate with IR light, and a big value means that there's no IR light source in front the sensor.

P Unused

Q Unused

R Read I^2C Extension Bus

Format of the command: **R, Slave_Write_Address, Register_Address, Number_of_Register ↵**
Format of the response: **r, Register_Data\r\n**

Effect: Read a given number of registers of an I^2C peripheral. Please provide register write address, i.e. odd address.
Examples: **R,C0,20,03 ↵**
Reads three registers at address 0x20, 0x21 and 0x22 of peripheral 0xC0

Note: All parameters must in hexadecimal format. The response will be in decimal format (0 to 255)

S Read the battery Voltage

Format of the command: **S ↵**
Format of the response: **s, BatteryVoltage\r\n**
Effect: Read the battery voltage. Divide the value by 620.5 to obtain the voltage in [V]. See chapter Battery for more information.

T Read TV remote buffer

Format of the command: **T ↵**
Format of the response: **t, TV_Addr, TV_Data\r\n**
Effect: Read the last address and data bytes received by the TV remote receiver.

U Unused

V Transmit a RC5 Data on the IR emitter

Format of the command: **V, TV_Addr, TV_Data ↵**
Format of the response: **v \r\n**

Effect: Send an address and a data through the IR emitter. All K-Junior close to the emitter, will receive the command as a TV remote control.
Example: **V,8,21 ↵**

Note: The address value can be configure from 0 to 31 (5 bits), and the data from 0 to 63 (6 bits).

W Write I^2C Extension Bus

Format of the command: **W, Slave_Address, Register_Address, Value ↵**
Format of the response: **w\r\n**
Effect: Write a value in a register of the selected extension.
Examples: **W,C0,40,32 ↵**
Writes 0x32 at address 0x40 of peripheral 0xC0
Note: All parameters must in hexadecimal format.

X Reserved

Y Write many data on the I^2C Bus

Format of the command: **Y, Slave_Address, Register_Address, NbData,Value1,Value2,…,ValueNb ↵**
Format of the response: **Y\r\n**
Effect: Write a value in a register of the selected extension.
Examples: **Y,C0,40,03,32,3C,F0 ↵**
Writes 0x32, 3C and F0 at address 0x40 of peripheral 0xC0. If the peripheral manage it, each new data are written to the next register.
Note: All parameters must in hexadecimal format.

Z Processor Reset

Format of the command: **Z ↵**
Format of the response: **z\r\n**
Effect: This command allows resetting the K-Junior as it was cycled On/Off

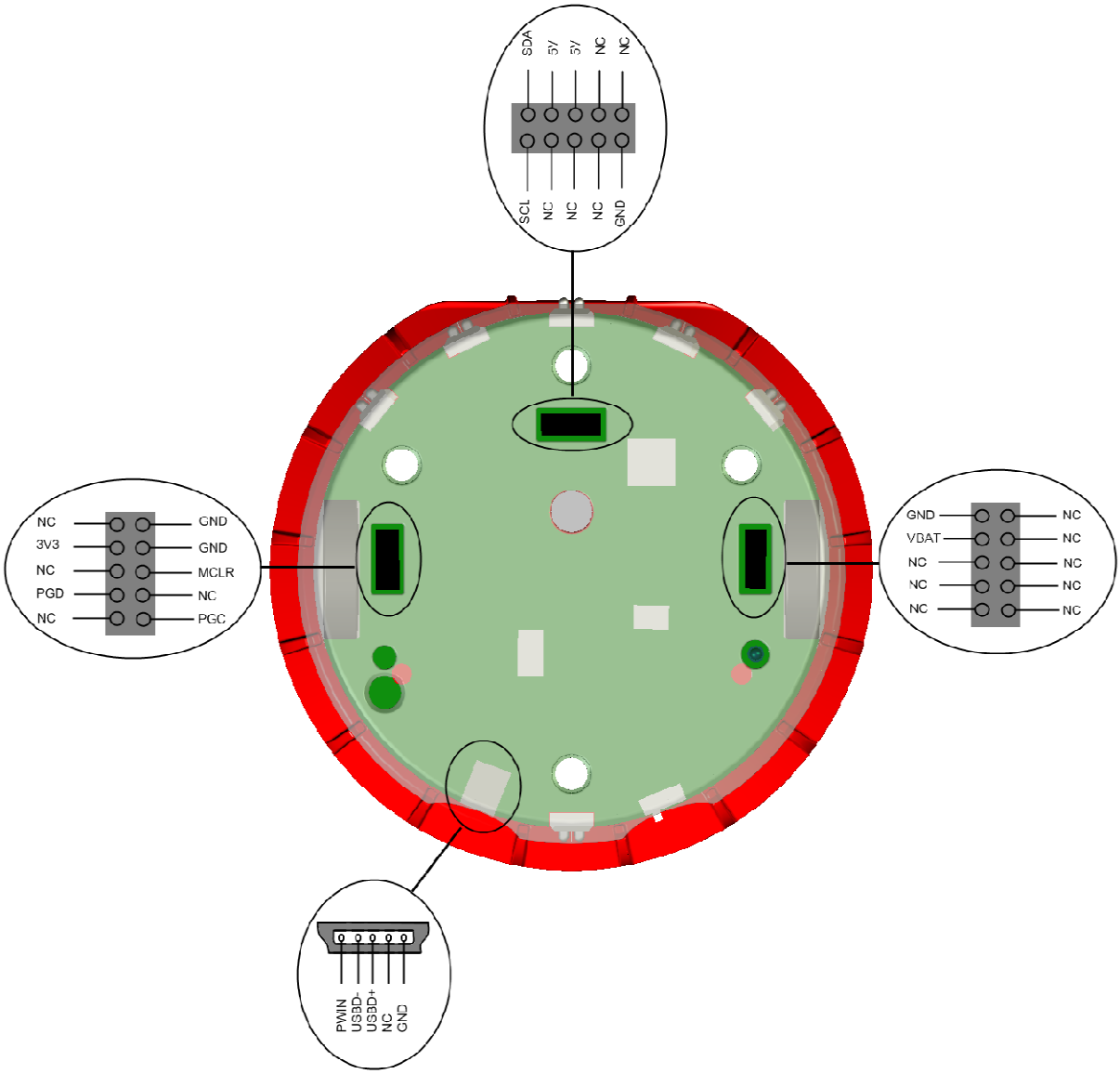
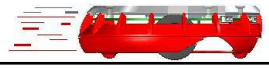


Figure B.1: K-Junior connectors pinning

Note: The PWIN signal, on the mini-USB connector, is the Power In to charge the battery. Apply a +5V between this pin and the GND to charge the battery.

C WARRANTY



K-TEAM warrants that K-Junior Pack, respectively K-Junior Pack Deluxe, is free from defects in materials and workmanship and in conformity with the respective specifications of the product for the minimal legal duration, respectively one year from the date of delivery.

Upon discovery of a defect in materials, workmanship or failure to meet the specifications in the Product during the afore mentioned period, Customer must request help on K-Team Internet forum on **http://www.k-team.com/kforum/.** by detailing:

- The type of K-Junior used (package, version).
- The expansion modules.
- The programming environment of the robot (standard, version, OS).
- The standard use of Product before the appearance of the problem.
- The description of the problem.

If no answers have been received within two working days, Customer can contact K-TEAM support by phone or by electronic mail with the full reference of its order and K-Junior serial number.

K-TEAM shall then, at K-TEAM's sole discretion, either repair such Product or replace it with the equivalent product without charging any technical labor fee and repair parts cost to Customer, on the condition that Customer brings such Product to K-TEAM within the period mentioned before. In case of repair or replacement, K-TEAM may own all the parts removed from the defective Product. K-TEAM may use new and/or reconditioned parts made by various manufacturers in performing warranty repairs and replacement of the Product. Even if K-TEAM repairs or replaces the Product, its original warranty term is not extended.

This limited warranty is invalid if the factory-applied serial number has been altered or removed from the Product.

This limited warranty covers only the hardware and software components contained in the Product. It does not cover technical assistance for hardware or software usage and it does not cover any software products contained in the Product. K-TEAM excludes all warranties expressed or implied in respect of any additional software provided with Product and any such software is provided "AS IS" unless expressly provided for in any enclosed software limited warranty. Please refer to the End User License Agreements included with the Product for your rights with regard to the licensor or supplier of the software parts of the Product and the parties' respective obligations with respect to the software.

This limited warranty is non-transferable.

It is likely that the contents of Customer's flash memory will be lost or reformatted in the course of the service and K-TEAM will not be responsible for any damage to or loss of any programs, data or other information stored on any media or any part of the Product serviced hereunder or damage or loss arising from the Product not being available for use before, during or after the period of service provided or any indirect or consequential damages resulting therefore.

IF DURING THE REPAIR OF THE PRODUCT THE CONTENTS OF THE FLASH MEMORY ARE ALTERED, DELETED, OR IN ANY WAY MODIFIED, K-TEAM IS NOT RESPONSIBLE WHATEVER. CUSTOMER'S PRODUCT WILL BE RETURNED TO CUSTOMER CONFIGURED AS ORIGINALLY PURCHASED (SUBJECT TO AVAILABILITY OF SOFTWARE).

Be sure to remove all third parties' hardware, software, features, parts, options, alterations, and attachments not warranted by K-TEAM prior to Product service. K-TEAM is not responsible for any loss or damage to these items.

This warranty is limited as set out herein and does not cover, any consumable items (such as batteries) supplied with the Product; any accessory products which is not contained in the Product; cosmetic damages; damage or loss to any software programs, data, or removable storage media; or damage due to (1) acts of God, accident, misuse, abuse, negligence, commercial use or modifications of the Product; (2) improper operation or maintenance of the Product; (3) connection to improper voltage supply; or (4) attempted repair by any party other than a K-TEAM authorized robot service facility.

This limited warranty does not apply when the malfunction results from the use of the Product in conjunction with any accessories, products or ancillary or peripheral equipment, or where it is determined by K-Team that there is no fault with the Product itself.

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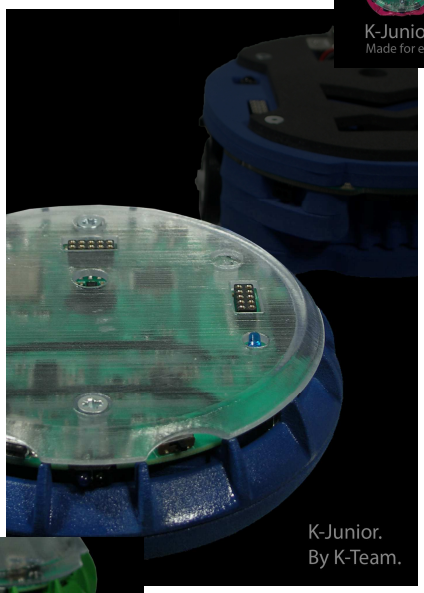

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